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## EUROPEAN PATENT APPLICATION

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㉙ **Fuel pump.**

㉚ A reciprocating plunger fuel injection pump includes a plunger (17) slidable in a bore (16). A pair of axially spaced grooves (29, 30) are formed in the wall of the bore and are interconnected by a passage (32). Associated with the grooves are a pair of changeover valves (36, 37) which are each placed in one position when the pump is supplying heavy fuel to allow fuel collecting in the grooves to flow to a drain. The valves are placed in their alternative positions when light fuel is being supplied by the pump to connect one groove with a source (39) of lubricating oil and the other groove with a lubricating oil drain.

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This invention relates to a fuel pump for supplying fuel to an internal combustion engine and of the kind comprising a pump body in which is defined a bore, a plunger reciprocable within the bore and extending from one end thereof, the other end of the bore defining a pumping chamber having an outlet to a fuel injection nozzle of an associated engine, means for supplying fuel to the pumping chamber and further means for varying the quantity of fuel delivered from the pumping chamber during inward movement of the plunger, a first groove in the wall of the bore and a second groove in the wall of the bore, said second groove being positioned intermediate said first groove and said one end of the bore and both grooves being covered by the pumping plunger.

Such a pump is known from GB-A-2129883 and can be used to deliver light or heavy fuel to an engine, the heavy fuel being a so called residual fuel which requires to be heated before it can be pumped and delivered to the engine. With such pumps it is the usual practice when stopping the engine, to purge the pump of the heavy fuel by running it for a period of time on light fuel. This avoids the possibility of the heavy fuel solidifying in the various passages within the pump and thereby preventing or hindering restarting of the engine without heating the pump. Moreover, the engine is started using the light fuel.

In the aforesaid pump the second groove is connected to a source of lubricating oil and the first groove is connected to a drain. In the first groove collects lubricating oil which is carried along the working clearance between the plunger and the bore from the second groove and also fuel which leaks along the working clearance from said other end of the bore. The leakage of fuel is minimised by providing a third groove intermediate the first groove and the port, the third groove being connected to the fuel inlet.

One of the difficulties experienced with the aforesaid pump is that some heavy fuels are unstable and when mixed with lubricating oil form a lacquer which can fill the working clearance between the plunger and the bore thereby preventing the plunger sliding in the bore. Furthermore, there is a constant loss of lubricating oil from the pump.

It is possible to design the pump to operate on certain types of heavy fuel without the need to supply lubricating oil to the pump. This overcomes the problem of lacquer formation and the continual loss of lubricating oil. However, with such a pump it is necessary when changing over to the light fuel to provide for lubrication of the plunger.

The object of the present invention is to provide a pump of the aforesaid kind in a simple and convenient form.

According to the invention in a pump of the kind specified there is provided a passage which interconnects the first and second grooves, and a pair of changeover valves for controlling liquid flow to and

from the grooves respectively, the first one of said valves when in one position connecting the associated groove to a drain and being in said one position when heavy fuel is being pumped by the pump and in its other position connecting the associated groove to a source of lubricating oil under pressure and the second one of said valves when in one position connecting the associated groove to the drain and being in said one position when heavy fuel is being pumped by the pump and in its other position connecting the associated groove to a lubricating oil drain, the changeover valves being in their said other positions when light fuel is being pumped by the pump, the lubricating oil flowing between the grooves through said passage.

An example of a pump in accordance with the invention will now be described with reference to the accompanying drawing which shows a sectional side elevation of a portion of the pump.

Referring to the drawing the pump comprises a hollow housing 10 in which is located a pump barrel 11. The barrel is flanged and is located against a step 12 in the housing and is retained in the housing by an end closure 13 which defines an outlet 14 from the pumping chamber 15 which is defined in part by a bore 16 in the pump barrel.

Slidable within the bore 16 is a pumping plunger 17 which extends from the bore and has its end engaged by a cup shaped tappet 18 which is slidable within the housing. The tappet in use is engaged by an engine driven cam so that the plunger is moved inwardly in timed relationship with the associated engine. The head 20 of the plunger is engaged by a spring abutment 21 against which is located one end of a coiled compression spring 22. The other end of the spring engages a further spring abutment 23 which locates against a step defined in the housing and which locates against a flange defined on an angularly adjustable sleeve 24 which is located about a projecting portion of the pump barrel. The sleeve is provided with axial slots in which are located tongues respectively formed on the plunger and the sleeve can be moved angularly by means of a rack bar 25 so that the angular setting of the plunger within the bore can be adjusted.

Formed in the wall of the bore are in the particular example, a pair of ports 26 which are uncovered by the inner end of the plunger as the latter moves outwardly under the action of the spring 22. The ports 26 communicate with a fuel supply gallery 27 defined about the pump barrel and which in use, is connected to a source of fuel under pressure. The ports 26 are covered by the plunger during its inward movement and once covered the fuel in the pumping chamber is pressurised and delivered through the outlet 14 the latter being provided with the conventional form of delivery valve.

On the periphery of the plunger there is defined

a pair of helical control edges 28 which form the boundary of a pair of grooves which communicate with the pumping chamber 15. When during the inward movement of the plunger the edges 28 uncover the ports 26, the fuel in the pumping chamber will flow through the ports 26 into the fuel supply gallery rather than through the outlet 14. The position during the inward movement of the plunger at which the control edges uncover the ports 26, depends upon the angular setting of the plunger within the barrel.

Formed in the wall of the bore is a first groove 29, a second groove 30 and a third groove 31. The grooves are axially spaced with the first groove being positioned between the second and third grooves, the latter groove being positioned between the first groove and the ports 26. The first and second grooves are interconnected by a passage 32 extending axially in the wall of the pump barrel and the two grooves are connected by way of passages in the barrel and housing with first and second openings 34, 35 on the exterior of the housing. The third groove 31 is connected by way of a passage formed in the pump barrel, with the fuel supply gallery 27.

Also provided is a pair of changeover valves 36, 37 which are associated with the openings 34, 35 respectively. The changeover valve 36 in one position, connects the opening 34 with a drain passage 38 and in its other position, connects the opening 34 with a source 39 of lubricating oil under pressure. The changeover valve 37 in one position connects the opening 35 with the drain passage 38 and in the other position connects the opening 35 with a drain passage 40.

When the pump is delivering heavy fuel such as residual fuel, to the engine the changeover valves 36 and 37 are in said one position. During the use of the pump the majority of the fuel which leaks passed the working clearance between the plunger and bore from the pumping chamber 15 collects in the groove 31 and is returned to the supply gallery. However, some fuel because of the pressure of fuel in the gallery 27 leaks along the working clearance towards the groove 29 and further towards the groove 30. The fuel provides for lubrication of the working surfaces of the plunger and the bore and the fuel collecting in the grooves 29 and 30 flows by way of the changeover valves 36, 37, to the drain passage 38. When it is desired to stop the engine the various passages and grooves within the pump must be purged of the heavy fuel and in order to achieve this the supply of fuel to the gallery 27 is changed to a light fuel and the changeover valves are both moved to their said other positions. The effect of this is to cause lubricating oil to be supplied to the groove 29 and to purge from the groove 29, the heavy fuel. This flows by way of the passage 32 into the groove 30 and then flows to the opening 35 and via the valve 37 to the passage 40. Gradually the heavy fuel will be purged from the

grooves and passages and of course from the gallery 27 and the pumping chamber. Once the purging process has taken place, the engine can be stopped. Restarting of the engine will be carried out with light fuel with lubricating oil supplied from the source 39 and once the engine has started and the pump has reached a proper working temperature, the valves 36 and 37 can be changed over to their said one positions and gradually the lubricating oil will be purged from the grooves 29 and 30, the purged oil flowing to the passage 38.

### Claims

1. A fuel pump for supplying fuel to an internal combustion engine comprising a pump body (10) in which is defined a bore (16), a plunger (17) reciprocable within the bore and extending from one end thereof, the other end of the bore defining a pumping chamber (15) having an outlet (14) to a fuel injection nozzle of an associated engine, means (26) for supplying fuel to the pumping chamber and further means (25, 28) for varying the quantity of fuel delivered from the pumping chamber (15) during inward movement of the plunger, a first groove (29) in the wall of the bore and a second groove (30) in the wall of the bore, said second groove being positioned intermediate said first groove and said one end of the bore and both grooves being covered by the pumping plunger characterised by a passage (32) interconnecting said first and second grooves (29, 30) and a pair of changeover valves (36, 37) for controlling liquid flow to and from the grooves respectively, the first one (36) of said valves when in one position connecting the associated groove to a drain and being in said one position when heavy fuel is being pumped by the pump and in its other position connecting the associated groove to a source (39) of lubricating oil under pressure and the second one (37) of said valves when in one position connecting the associated groove to the drain and being in said one position when heavy fuel is being pumped by the pump and in its other position connecting the associated groove to a lubricating oil drain, the changeover valves being in their said other positions when light fuel is being pumped by the pump, the lubricating oil flowing between the grooves (29, 30) through said passage (32).
2. A fuel pump according to Claim 1, characterised in that the first changeover valve (36) controls the flow of liquid to the first groove (29).
3. A fuel pump according to Claim 2, characterised in that said passage (32) extends axially in the

wall of a pump barrel (11) in which said bore (16) is formed and which is secured within the pump body (10).

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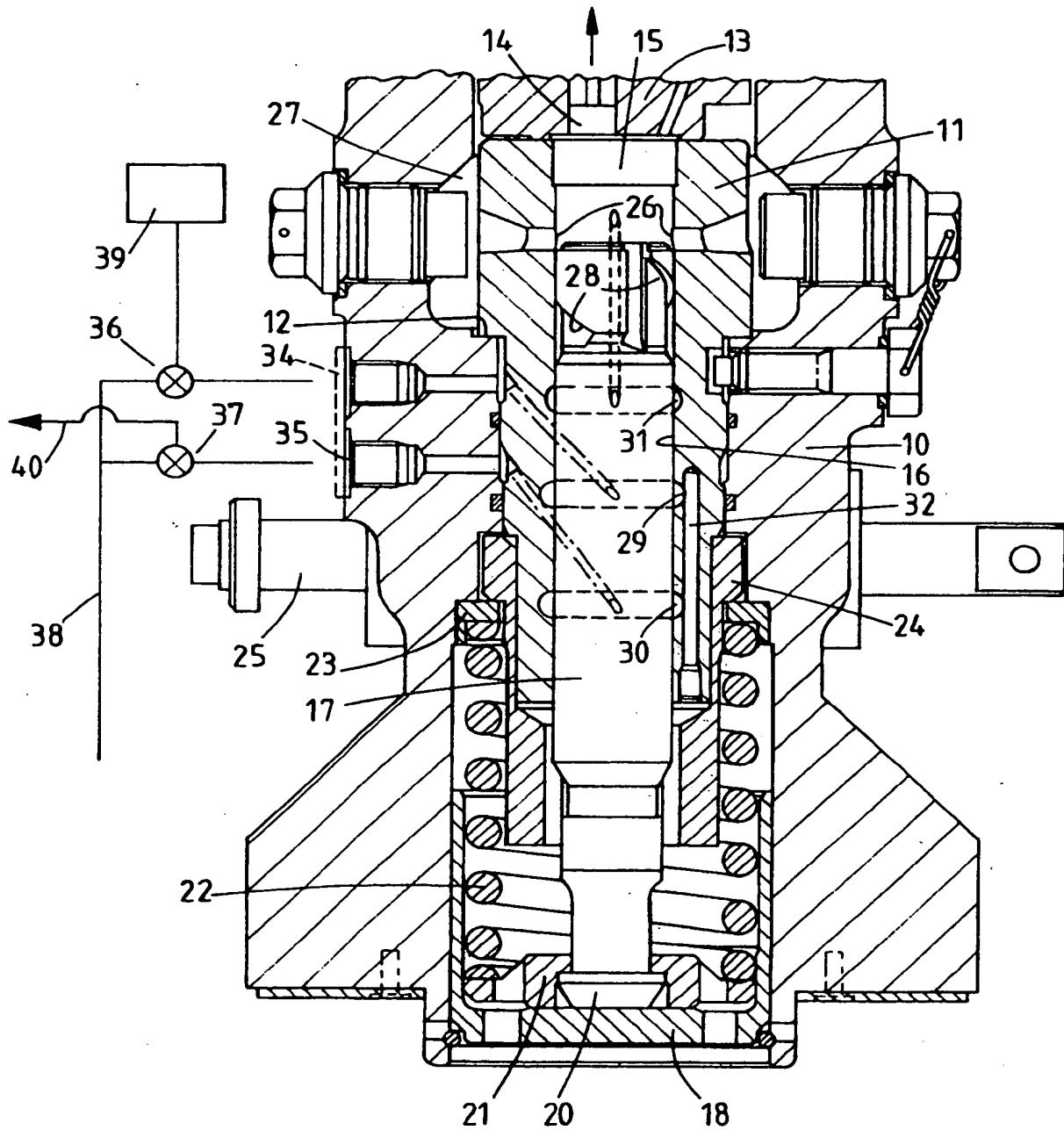
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## EUROPEAN SEARCH REPORT

Application Number

EP 92 30 8571

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A,D	GB-A-2 129 883 (LUCAS INDUSTRIES P.L.C.) * page 1, line 3 - page 2, line 74; figure 1 *	1	F02M43/02 F02M59/44
A	GB-A-2 077 862 (LUCAS INDUSTRIES LTD.) * page 1, line 3 - line 128; figure 1 *	1	
A	CH-A-501 832 (BRYCE BERGER LTD.)		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F02M
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15 JANUARY 1993	Examiner VAN ZOEST A.P.
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons  &amp; : member of the same patent family, corresponding document</p>			

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